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Program Report

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1992 Annual Status Report

A Summary of Aquatic Vegetation Monitoring at Selected Locations in Pools 4, 8, 13, and 26 and La Grange Pool of the Upper Mississippi River System

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A Summary of Aquatic Vegetation Monitoring at Selected Locations in Pools 4, 8, 13, and 26 and La Grange Pool of the Upper Mississippi River System

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Preface

The Long Term Resource Monitoring Program (LTRMP) was authorized under the Water Resources Development Act of 1986 (Public Law 99-662) as an element of the U.S. Army Corps of Engineers' Environmental Management Program. The LTRMP is being implemented by the Environmental Management Technical Center, a U.S. Geological Survey science center, in cooperation with the five Upper Mississippi River System (UMRS) States of Illinois, Iowa, Minnesota, Missouri, and Wisconsin. The U.S. Army Corps of Engineers provides guidance and has overall Program responsibility. The mode of operation and respective roles of the agencies are outlined in a 1988 Memorandum of Agreement.

The UMRS encompasses the commercially navigable reaches of the Upper Mississippi River, as well as the Illinois River and navigable portions of the Kaskaskia, Black, St. Croix, and Minnesota Rivers. Congress has declared the UMRS to be both a nationally significant ecosystem and a nationally significant commercial navigation system. The mission of the LTRMP is to provide decision makers with information for maintaining the UMRS as a sustainable large river ecosystem given its multiple-use character. The long-term goals of the Program are to understand the system, determine resource trends and effects, develop management alternatives, manage information, and develop useful products.

This report presents the results of aquatic vegetation surveys conducted by field station personnel under direction of the Environmental Management Technical Center during the 1992 growing season. Selected areas in Pools 4, 8, 13, and 26 of the Upper Mississippi River and La Grange Pool on the Illinois River were surveyed. This report satisfies, for 1992, Task 2.2.4.6, *Evaluate and Summarize Annual Present-Day Results* under Goal 2, *Monitor Resource Change* of the Operating Plan (U.S. Fish and Wildlife Service 1993). The purpose of this report is to provide a summary of data regarding the distribution and abundance of submersed aquatic vegetation collected from the field stations for 1992. This report was developed with funding provided by the Long Term Resource Monitoring Program.

1992 Annual Status Report
A Summary of Aquatic Vegetation Monitoring at Selected Locations in Pools 4, 8, 13, and 26 and La Grange Pool of the Upper Mississippi River System

by

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and Susan Romano-Pietzmeyer

Abstract

Aquatic vegetation of the Upper Mississippi River System is monitored as part of the Long Term Resource Monitoring Program. This report summarizes the 1992 effort of monitoring submersed aquatic vegetation (SAV) along transects permanently established in vegetated locations within four navigation pools of the Upper Mississippi River and one navigation pool of the Illinois River. More species of submersed aquatic macrophytes were found along transects in lower Pool 4 than in any other reach. La Grange Pool and Pool 26 transects had the fewest species. Across all pools, sago pondweed (*Potamogeton pectinatus*) and coon's tail (*Ceratophyllum demersum*) were the species most frequently found. Several species of SAV were seasonally dynamic at the transect locations, with changes in frequencies especially common among sago and curly (*P. crispus*), and species of narrow-leaved pondweeds. Many of the species in Pools 8 and 13 increased in frequencies between sampling periods, resulting in a significantly higher proportion of sites with SAV by the summer sampling period. Although frequencies of individual species changed during the growing season in Pools 4 and 26 and La Grange Pool, the proportion of sites with SAV remained stable. Community diversity within each pool was similar between sampling periods except in Pool 13 where diversity increased at most locations during the season.

Introduction

Aquatic vegetation of the Upper Mississippi River System (UMRS) is monitored as part of the Long Term Resource Monitoring Program (LTRMP; U.S. Fish and Wildlife Service 1993). The trends in the status of the vegetation are reported in annual status reports, and the data provide a baseline of information to which future observations can be compared. In combination with other component monitoring conducted for the LTRMP, the overall mission is to provide decision makers with scientifically sound and useful information for effective river management. The purpose of this report is to document transect sampling at selected locations in 1992. This report also provides an initial indication of features of submersed aquatic vegetation (SAV) that can be compared to future monitoring efforts.

Submersed macrophytes have always played an important role in the UMRS ecosystem. These plant communities provide food for migratory waterfowl (Korschgen et. al. 1988) and improve the water quality by stabilizing sediments, filtering out suspended materials, and taking up nutrients that can otherwise support nuisance algal growth (Barko et al. 1991). Submersed aquatic macrophytes also provide nursery areas for young fish, serve as spawning habitat, and support invertebrate populations by providing structure and surface area (Engel 1990).

We have been unable to understand or anticipate many changes in the distribution of SAV within the UMRS, partly because few studies have adequately addressed the questions. Biologists have high interest and concern for this important component, however, especially following the mid- to late-1980s when widespread and sudden declines in the abundance of wild celery *(Vallisneria americana)* from Pools 5 to 19 were observed (E. Nelson and C. Cheap, U.S. Fish and Wildlife Service, Winona, Minnesota, unpublished data; C. Korschgen, Northern Prairie Wildlife Research Center, Jamestown, North Dakota, unpublished data;

J. Lyons, U.S. Fish and Wildlife Service, McGregor, Iowa, personal communication; R. Anderson, Western Illinois University, Macomb, personal communication; W. Thrune, U.S. Fish and Wildlife Service, La Crosse, Wisconsin, personal communication). Among those especially concerned were biologists familiar with the history of the Illinois River. During the 1950s, SAV in much of the river rapidly disappeared and only remnant populations now survive (Talkington and Semonin 1991).

Long-term monitoring can increase our understanding of trends in this resource by addressing the following questions:

(1) How temporally and spatially dynamic is SAV in the UMRS?
(2) Are we observing short-term fluctuations in one or more species or is SAV becoming irreparably lost?
(3) Based on patterns observed, what factors most likely contribute to the observed changes?

The 1992 growing season was the second year we conducted field surveys for the LTRMP specifically to collect data on the distribution and relative abundance of SAV throughout each resource trend analysis pool. The objectives for monitoring aquatic vegetation in the UMRS are to

(1) document the presence and distribution of SAV within selected locations of the UMRS,
(2) compare current distribution of SAV with past or future distribution, and
(3) identify environmental factors potentially responsible for both long- and short-term changes in the distribution of SAV.

This report partially fulfills the first and second objectives. Fulfillment of the second objective would be accomplished over the course of the LTRMP beginning in the second year and gaining significance each year. Fulfillment of the third objective requires research in addition to monitoring. Measuring the effect of environment on abundance and distribution requires focused initiatives to explore plant response to key factors, singly or in combination with one another.

Study Areas

The LTRMP vegetation study areas include river reaches in the UMRS, four on the Mississippi River and one on the Illinois River (Figure 1). Study areas are referred to herein by the navigation pool designations according to the U.S. Army Corps of Engineers lock and dam system. Mississippi River navigation pools studied are Pool 4 (Mississippi River mile [M] 752–797), Pool 8 (M679–703), Pool 13 (M523–557), Pool 26 (M202–242), and La Grange Pool of the Illinois River (Illinois River mile [I] 80–158). River miles for the Mississippi are measured from the confluence of the Mississippi and Ohio Rivers and for the Illinois from the confluence of the Mississippi and Illinois Rivers.

These study pools were chosen, in part, to reflect important differences in geomorphology, floodplain land use, and water level management strategies that exist with the UMRS. Pools 4, 8, and 13 are geomorphically complex with numerous backwaters and braided side channels and contain the highest values of total cover for aquatic vegetation (Peck and Smart 1986). Relatively high percentages of the total aquatic area in these study reaches are composed of contiguous (to the main channel) backwaters, and relatively low percentages are composed of main channel (Table 1). Pool 26, in a lower impounded reach, is characterized by relatively low percentages of open water and aquatic vegetation and a high percentage of agriculture in the floodplain. A low percentage of the total aquatic area is composed of contiguous backwaters, and commensurately, a high percentage is composed of the main channel. La Grange Pool is similar to Pool 26 in floodplain

composition, but is similar to Pools 8 and 13 in composition of the aquatic area. In fact, La Grange Pool has the greatest percentage (52.2%) of contiguous backwaters among the LTRMP study areas, but aquatic vegetation is not present in most of them.

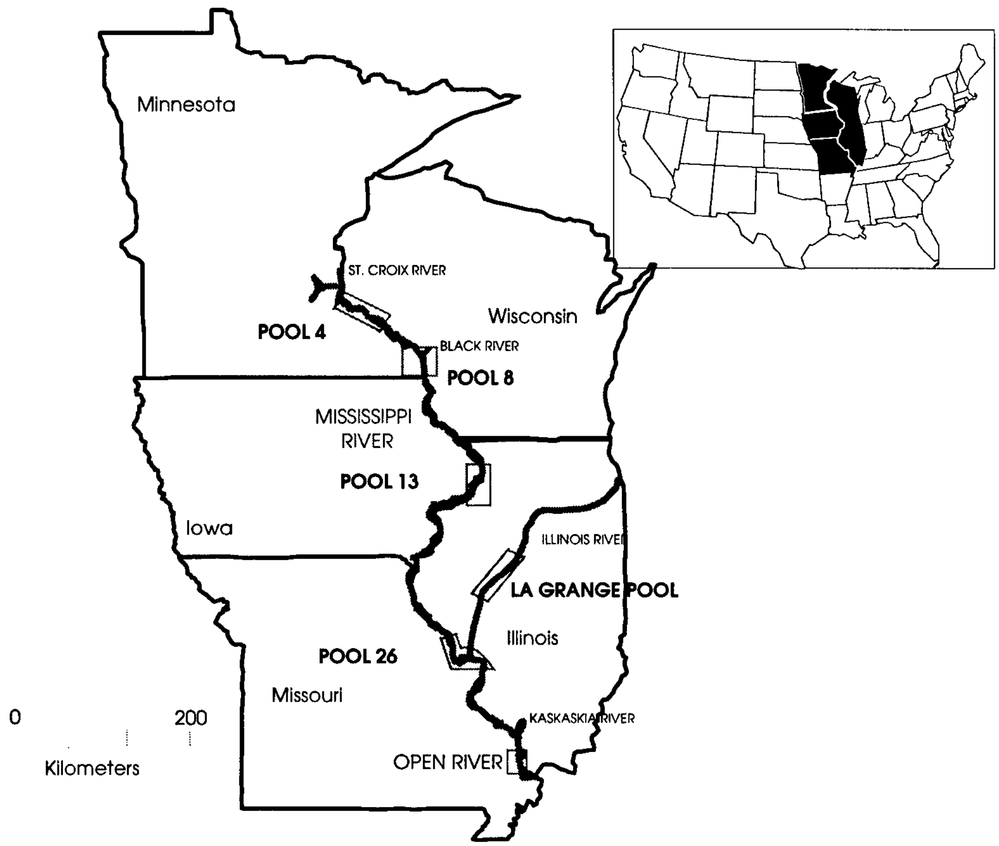

Figure 1. Main stem of the Upper Mississippi River System with the study reaches used in the Long Term Resource Monitoring Program submersed vegetation surveys of 1992 (Pools 4, 8, 13, 26, and La Grange Pool). The Open River reach was not selected as a study site because of the lack of habitat for submersed vegetation.

During 1992, monitoring was conducted in Pools 4, 8, 13, and 26 of the Mississippi River and in La Grange Pool of the Illinois River (Figure 1). Permanent transects, most of which were established in 1991, were monitored at several locations throughout each pool where vegetation has grown for most of the postimpoundment period.

In Pool 4, we sampled SAV at 10 contiguous backwater locations (Figure 2). The transect locations were distributed in both the upper and lower portions of the pool, but not in Lake Pepin (Appendix A). Upper pool locations included Dead Slough Lake, Goose Lake, Mud Lake, and Bay City Flats. Lower pool locations (below Lake Pepin) included Big Lake, Robinson Lake, Peterson Lake, and Lower Peterson Lake. We also monitored Rice Lake and Big Lake Bay, part of the Big Lake area.

Table 1. Key features of the floodplain and aquatic area compositions of the five Mississippi and Illinois River study reaches monitored for vegetation in 1992 for the Long Term Resource Monitoring Program.[a]

		Floodplain composition (%)[b]			Aquatic area composition (%)[c]	
Study reach	**Floodplain area (ha)**	**Open water[d]**	**Aquatic vegetation[e]**	**Agriculture**	**Contiguous backwater**	**Main channel**
Pool 4	28,358	50.5	10.0	12.1	21.3	10.5
Pool 8	19,068	40.1	14.4	0.9	30.6	14.2
Pool 13	34,528	29.7	8.6	27.9	28.5	24.7
Pool 26	51,688	13.4	1.4	65.4	17.3	54.4
La Grange Pool, Illinois River	89,554	15.7	2.2	59.6	52.2	21.3

[a] Table from Gutreuter et al. (1997).
[b] Data on floodplain composition are from Laustrup and Lowenberg (1994).
[c] Aquatic area is that portion of the floodplain that is inundated at normal water elevations. Data on the composition of aquatic areas are from the Long Term Resource Monitoring Program aquatic areas spatial database.
[d] Submersed vegetation, when detectable, was merged with the open water class. Main channel includes area in the navigation channel and main channel border areas.
[e] Aquatic vegetation includes rooted floating aquatics and emergents only.

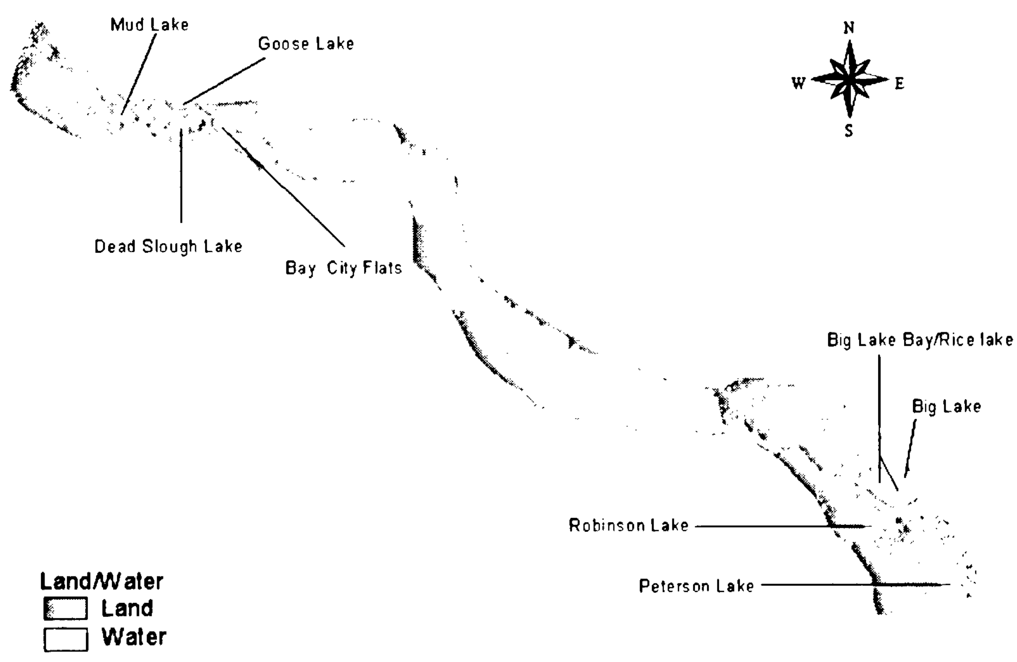

Figure 2. Pool 4, Upper Mississippi River, transect locations for the 1992 monitoring of submersed aquatic vegetation for the Long Term Resource Monitoring Program.

In Pool 8, we sampled SAV for the second year at five locations including Target Lake, Lawrence Lake, a backwater area near Goose Island, Shady Maple, and the interior of Horseshoe Island, which is the site of of one of the U.S. Army Corps of Engineers Habitat Rehabilitation and Enhancement Projects (Figure 3). An additional set of transects was added at a small isolated backwater near Stoddard, Wisconsin (Appendix A).

In Pool 13, we sampled SAV at seven locations (Figure 4). All locations were selected the previous year and were distributed primarily in the middle and lower portions of the pool. Locations included Brown's Lake, Savanna Bay, Spring Lake, Pomme de Terre, Potter's Marsh, Lower Johnson Creek, and an aquatic area along the Johnson Creek Levee (Appendix A).

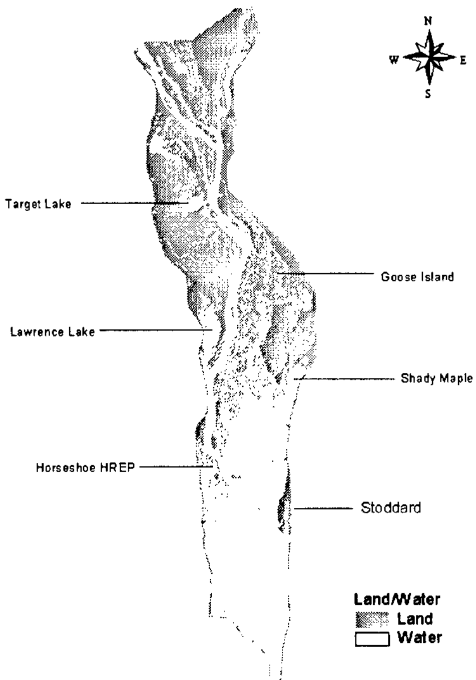

Figure 3. Pool 8, Upper Mississippi River, transect locations for the 1992 monitoring of submersed aquatic vegetation for the Long Term Resource Monitoring Program.

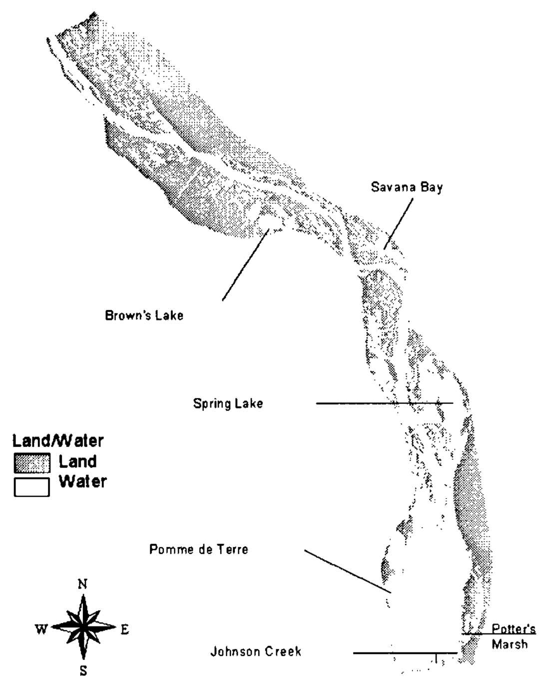

Figure 4. Pool 13, Upper Mississippi River, transect locations for the 1992 monitoring of submersed aquatic vegetation for the Long Term Resource Monitoring Program.

In Pool 26, we sampled SAV for the second year at three vegetated backwater locations (Figure 5). Transect locations were distributed in Swan Lake, Stump Lake, and in the Calhoun Point area, which consists of several backwater lakes, sloughs, and wet-weather ponds (Appendix A). The Illinois Department of Natural Resources manages the Stump Lake and Calhoun Point areas and uses control structures and pumping to drain these areas for waterfowl management. Fuller Lake, at the northern end of Swan Lake, was added to the monitoring in 1992.

In La Grange Pool, we sampled SAV for the second year at three backwater locations including Point Lake, Spring Lake, and Banner Marsh (Figure 6). The three backwaters are among the few locations where submersed vegetation can still be found within this river reach. These backwaters are classified as isolated and are protected from the main stem of the Illinois River by agricultural levees. However, Point Lake often receives overflow water from the main channel of the Illinois River. Banner Marsh (Bulrush Pond) and Spring Lake are actively managed for fishing and are completely isolated. A fourth monitoring site, a channel border near Grape Island, was added in 1992.

Methods

Transect Sampling

We positioned transects at regular intervals, from 50 to 200 m apart depending on the size of the area, and perpendicular to shorelines. In some large backwaters, we positioned transects in groups of three or four and placed several groups throughout the backwater. For example, Peterson Lake (Pool 4) has three transects in the upper portion, three in the middle portion, and four in the lower portion. We did no sampling in the areas between the groups.

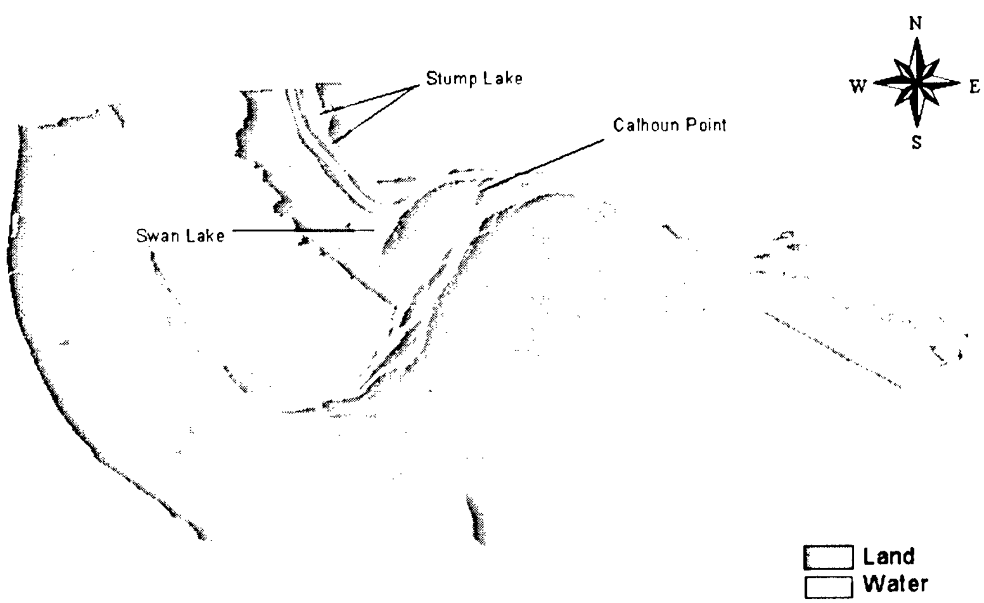

Figure 5. Pool 26, Upper Mississippi River, transect locations for the 1992 monitoring of submersed aquatic vegetation for the Long Term Resource Monitoring Program.

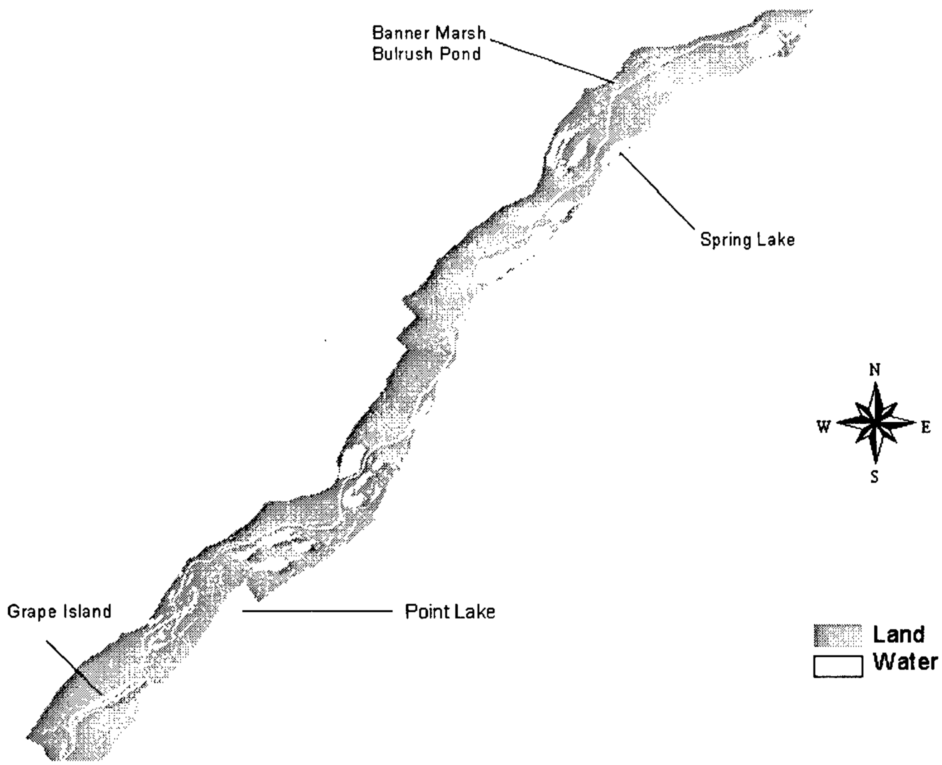

Figure 6. La Grange Pool, Illinois River, transect locations for the 1992 monitoring of submersed aquatic vegetation for the Long Term Resource Monitoring Program.

In most transect locations, sampling was performed twice during the growing season to observe seasonal changes in species composition and relative frequencies (Appendix A). In Pool 8, the Stoddard backwater was first monitored during the summer sampling period of 1992, and in Pool 26, Stump and Fuller Lakes were only sampled during spring because of low water levels by summer. Sampling dates for each pool location and for each sampling period are listed in Appendix A.

Sampling along the transects was at regularly spaced intervals (sites) such that a grid-like sampling scheme of evenly distributed sampling sites was imposed over a backwater or vegetated area. Sites were generally 15 m apart in Pools 8, 13, and 26, and in La Grange Pool, but 30 m apart in Pool 4 because several of the backwaters were too large to sample at the 15 m interval (Appendix A). The sampling technique was modified from a technique used by Jessen and Lound (1962). At each site along a transect, a 2-m diameter sampling area was divided into three equal portions. We sampled plants once in each of the three portions by casting a long-handled thatching rake to the bottom and twisting it to snag plants—instead of dragging it as did Jessen and Lound. The thatching rake has a 15-inch head with 20, 5-inch-long teeth and samples about 0.1 m^2. The submersed species on the rake were identified and recorded. After all three casts were made, each species recovered was assigned a rating from 1 to 4—instead of from 1 to 5 as Jessen and Lound—based on the number of times each species appeared on the rake at each sampling site. A rating of 4 was assigned only if a species completely covered the rake teeth on all three casts.

If floating-leaved species were present, they were recorded and assigned a rating based on four cover classes (1–25% visible vegetative cover within the sample area, 26–50%, 51–75%, and 76–100%). Floating-leaved species are listed in the taxa list (Appendix B), but not included in the analysis.

Fassett (1966) and Gleason and Cronquist (1991) were the primary keys used for plant identification. Scientific nomenclature and common names were taken from the U.S. Department of Agriculture PLANTS Database on the Internet (www.itis.usda.gov/). A list of common and scientific names of plants is found in Table 2.

If a species was not collected during the 1991 season, or could not be identified in the field, it was collected for reference and archiving. After drying, pressing, mounting, and labeling, specimens were stored at each field station. Two species of narrow-leaved pondweeds, small pondweed (*Potamogeton pusillus*) and leafy pondweed (*P. foliosus*), collectively referred to as small and leafy pondweeds were not distinguished from each other during field sampling and were also combined during analysis. Two species of macroalgae, chara (*Chara* spp.) and nitella (*Nitella* spp.), were included in the analysis with the vascular plants.

Table 2. Submersed and floating-leaved aquatic vegetation most likely to be found in the area covered by the Long Term Resource Monitoring Program, arranged alphabetically by common name within family.

Family	Common name[a,b]	Scientific name[a]
Ceratophyllaceae	Coon's tail, coontail	*Ceratophyllum demersum*
Characeae	Chara	*Chara* spp.
Characeae	Nitella	*Nitella* spp.
Haloragaceae	Northern watermilfoil[b], shortspike watermilfoil	*Myriophyllum sibiricum* Komarov
Haloragaceae	Eurasian watermilfoil[b], spike watermilfoil	*Myriophyllum spicatum* L.
Hydrocharitaceae	Canadian waterweed	*Elodea canadensis*
Hydrocharitaceae	Western waterweed	*Elodea nuttallii* Planch.
Hydrocharitaceae	Wild celery[b], American eelgrass	*Vallisneria americana* Michx.
Lentibulariaceae	Common bladderwort	*Utricularia macrorhiza* Le Conte
Najadaceae	Brittle waternymph	*Najas minor* All.
Najadaceae	Nodding waternymph, bushy pondweed	*Najas flexilis* (Willd.) Rostk. & Schmidt
Najadaceae	Slender waternymph	*Najas gracillima* (A. Braun ex Engelm.) Magnus
Najadaceae	Southern waternymph	*Najas guadalupensis* (Spreng.) Magnus
Nymphaeaceae	American lotus	*Nelumbo lutea* (Willd.) Pers.
Nymphaeaceae	Yellow pondlily	*Nuphar lutea* (L.) Sm.
Nymphaeaceae	White waterlily	*Nymphaea odorata* Ait.
Onagraceae	Floating primrosewillow	*Jussiaea repens* L.

Table 2. Continued.

Family	Common name[a,b]	Scientific name[a]
Pontederiaceae	Water stargrass, grassleaf mudplantain	*Heteranthera dubia* (Jacq.) MacM.
Potamogetonaceae	Curly pondweed, curlyleaf pondweed	*Potamogeton crispus* L.
Potamogetonaceae	Flatstem pondweed	*Potamogeton zosteriformis* Fern.
Potamogetonaceae	Illinois pondweed	*Potamogeton illinoisensis* Morong.
Potamogetonaceae	River pondweed[b], longleaf pondweed	*Potamogeton nodosus* Poir
Potamogetonaceae	Leafy pondweed	*Potamogeton foliosus* Raf.
Potamogetonaceae	Variableleaf pondweed	*Potamogeton gramineus* L.
Potamogetonaceae	Ribbonleaf pondweed	*Potamogeton epihydrus* Raf.
Potamogetonaceae	Richardson's pondweed	*Potamogeton richardsonii* (Benn.) Rydb.
Potamogetonaceae	Small pondweed	*Potamogeton pusillus* L.
Potamogetonaceae	Sago pondweed	*Potamogeton pectinatus* L.
Ranunculaceae	Longbeak buttercup	*Ranunculus longirostris* Godron.
Ranunculaceae	White water-crowfoot	*Ranunculus trichophyllus* Chauix.
Zannichelliaceae	Horned pondweed	*Zannichellia palustris* L.

[a] Scientific nomenclature and common names follow the U.S. Department of Agriculture PLANTS Database on the Internet (www.itis.usda.gov/).

[b] Common names most often used by Upper Mississippi River managers are also included if different from the common names listed in the U.S. Department of Agriculture PLANTS Database.

Environmental Factors

To acquire information on the relation between macrophyte presence and sediment texture, we recorded the sediment type most often found for each transect. The sediment types were cataloged subjectively into four broad categories and subsequently condensed into three categories (silt/clay, mostly silt with sand, mostly sand with silt) based on visual and tactile characteristics. Water depth was measured at each transect site with a depth pole.

Statistical Analysis

The frequency of a species is defined as $f_i = j_i/n$ where j_i = number of sample sites containing species i on at least one of the three rake casts, and n = total number of sample sites. Relative frequency of a species is defined as $rf_i = e_i/Ef$ where e_i = the number of rake grabs for species i and Ef = number of rake grabs for all species. To test for significant changes in frequencies for a species between the two sampling periods, a value for Z was calculated with the following formula:

$$Z = p_1 - p_2 / \sqrt{pq[(1/n_1)+(1/n_2)]}$$

where

$p = j_1 + j_2 / n_1 + n_2$;

$q = 1-p$;

p_1 and p_2 are the spring and summer proportions, respectively;

n_1 and n_2 equal the number of sampling sites, spring and summer, respectively;

j_1 and j_2 = number of times species j was found during the spring and summer sampling periods, respectively; and

Z-values were calculated for each species and for each location within a pool.

Chi-square tests were used to test for significant changes in the proportion of sites with SAV to the total number of sites sampled between sampling periods. All analysis was done using the Statistical Analysis System (SAS; SAS Institute Inc., Cary, North Carolina).

Informal Surveys

To gain perspective on the distribution and composition of SAV in habitats other than transect locations, we surveyed many portions of each pool where vegetation was likely to be present. Aerial photographs and bathymetry maps were used to locate sites supporting or likely to support SAV. Pools 4, 8, and 13 were surveyed by boating along channel border habitats and through other areas most likely to support vegetation but not covered by transect sampling. If vegetated areas or patches of vegetation were seen at or near the surface, samples were gathered with a rake. An estimate of abundance (rare, common, abundant) was given to each species. Species composition, approximate bed size, water depth, substrate type, and location of the vegetated areas and patches were recorded. Informal surveys were not conducted in Pool 26 or in La Grange Pool because previous surveys revealed that areas vegetated with SAV are generally scarce in those two pools.

Results and Discussion

All Pools

During 1992, we found 16 species of submersed aquatic plants along transects across study pools. Two of the species found are macroalgae belonging to the muskgrass family (Characeae). We also found four species of floating-leaved plants and have included them in our species list (Appendix B). The most submersed aquatic species found at transect sites during a sampling period was 14 (Pool 4 during summer sampling), and the least was five (Pool 8 during spring sampling). Coon's tail, sago pondweed, and curly pondweed were the only species sampled in every study pool during both spring and summer sampling. Eurasian watermilfoil, found in four of the five pools, was also a prevalent species, reaching high frequencies in La Grange Pool and Pool 8. Eurasian watermilfoil, for reasons unknown to us, has not been found in Pool 26. Wild celery was most common in Pools 4 and 13, was present at a frequency less than 1% in Pool 8, and was not found in Pool 26 or La Grange Pool. Many species remained at frequencies less than 10% throughout all pools (Table 3).

Table 3. Frequencies and relative frequencies (%) of species in Pools 4, 8, 13, and 26 of the Upper Mississippi River and La Grange Pool (LG) of the Illinois River in 1992.[a]

	Spring										Summer									
	4		8		13		26		LG		4		8		13		26		LG	
Species	Freq	Rel freq	Freq	Rel freq	Freq	Rel freq	Freq	Rel freq	Freq	Rel freq	Freq	Rel freq	Freq	Rel freq	Freq	Rel freq	Freq	Rel freq	Freq	Rel freq
Canadian waterweed	5.4	4.8	–	–	–	–	0.7	0.3	–	–	8.8	8.7	–	–	1.8	1.3	0.7	0.3	–	–
Chara	–[b]	–	–	–	–	–	–	–	5.1	3.8	<0.1	0.1	–	–	0.3	0.2	–	–	8.3	7.3
Coon's tail	19.5	20.8	2.0	3.4	6.3	5.6	31.7	34.9	17.6	12.2	15.6	19.0	8.8	10.8	24.3	17.9	33.2	34.8	21.2	21.3
Curly pondweed	19.4	24.8	20.8	51.3	8.4	8.4	17.8	16.1	35.3	22.3	2.5	2.0	16.6	23.8	8.9	5.4	4.5	1.8	6.1	3.6
Eurasian watermilfoil	4.4	4.2	9.4	16.5	0.5	0.5	–	–	69.8	56.2	6.3	5.5	19.8	24.0	11.6	7.3	–	–	56.8	62.2
Flatstem pondweed[c]	2.4	1.9	–	–	0.1	0.1	–	–	–	–	3.6	2.6	0.4	0.5	10.4	8.7	–	–	–	–
Horned pondweed[d]	–	–	0.4	0.6	–	–	–	–	–	–	0.5	0.5	–	–	–	–	–	–	–	–
Longleaf pondweed	1.0	1.0	–	–	2.0	2.3	0.2	0.2	2.9	1.3	0.9	0.7	0.4	0.4	5.7	3.7	–	–	3.8	2.4
Nitella	–	–	–	–	–	–	–	–	–	–	<0.1	0.1	–	–	–	–	–	–	–	–
Nodding waternymph	–	–	–	–	–	–	–	–	–	–	0.8	1.1	1.6	2.2	3.3	2.1	–	–	–	–
Sago pondweed	28.3	38.7	16.3	28.1	49.2	81.9	46.2	41.4	7.3	3.3	16.1	16.3	28.3	37.4	53.6	47.9	54.2	58.7	3.0	0.3
Small and leafy pondweeds	1.2	0.8	–	–	–	–	10.3	7.0	<0.1	0.2	4.3	4.1	–	–	0.2	0.1	7.1	3.2	–	–
Southern waternymph	–	–	–	–	–	–	–	–	–	–	–	–	0.1	0.1	1.5	0.8	1.4	1.2	–	–
Water stargrass[d]	1.7	1.2	–	–	p	p	–	–	–	–	9.5	9.1	0.5	0.5	?[c]	?[c]	–	–	–	–
Western waterweed[e]	–	–	–	–	–	–	–	–	2.2	0.7	–	–	–	–	–	–	–	–	4.5	2.8
Wild celery	2.2	1.7	–	–	1.1	1.1	–	–	–	–	22.3	30.2	0.1	0.2	6.6	4.6	–	–	–	–

[a] Data are based on all transect locations that were sampled during both sampling periods within a pool. Rounding may cause relative frequency columns to not total 100%.
[b] The symbol "–" indicates the species was not found.
[c] Flatstem pondweed relative frequency may also include water stargrass in Pool 13.
[d] Horned pondweed and water stargrass were found in Pool 26 in a backwater that was not included in this analysis.
[e] Verification of specimen needed for positive identification.

Relative frequencies revealed interesting patterns. In Pools 4, 8, 13, and 26, coon's tail, sago pondweed, and curly pondweed represented more than 80% of the relative frequencies during spring sampling. By summer sampling, a somewhat more balanced distribution was observed in two pools. In Pool 4, several species, including coon's tail, Canadian waterweed, Eurasian watermilfoil, sago pondweed, small and leafy pondweeds, water stargrass, and wild celery, contributed to more than 90% of the relative frequencies. In Pool 13, Eurasian watermilfoil, flatstem pondweed (or water stargrass), coon's tail, and sago pondweed represented more than 80% of the relative frequencies. In Pool 8, however, more than 70% of the relative frequencies were still shared by coon's tail, curly pondweed, and sago pondweed. Also, in Pool 26, coon's tail and sago pondweed remained the dominant species during the summer sampling period with more than

90% of the relative frequencies. The relative frequency of Eurasian watermilfoil was more than 50% in both spring and summer in La Grange Pool. In all pools, curly pondweed dropped in relative frequency, sometimes as much as 90%, between spring and summer sampling periods. The biggest change occurred in Pool 8, where it dropped from 51.6 (its highest relative frequency) to 23.8%, and in Pool 4 where it dropped from 24.8 to 2% (Table 3).

The proportion of sites with SAV to the total number of sampling sites increased significantly (based on Chi-square tests) in Pools 8 and 13, but remained similar in Pools 4 and 26 and La Grange Pool (Table 4). In Pool 4, some species increased in frequency while others decreased, thus the proportion of sites with SAV did not change significantly between the spring and summer sampling periods. In Pools 8 and 13, increases in frequencies of several species over the sampling season were great enough to significantly influence the proportion of sites vegetated with submersed species. The frequency of most species in Pool 26 and La Grange Pool did not change significantly between spring and summer sampling periods, thus, the proportion of vegetated sites was not significantly different between spring and summer.

Table 4. Proportion of sites with submersed aquatic vegetation to the total number of sites sampled at transect locations during the 1992 spring and summer sampling periods.

Location	Spring	Summer
Pool 4	54.2	50.1 ($p > 0.900$)[a]
Pool 8	42.3	53.3 ($p < 0.001$)
Pool 13	58.4	72.2 ($p <. 0.001$)
Pool 26	78.6	85.6 ($p > 0.800$)
La Grange Pool	86.8	83.9 ($p > 0.420$)

[a] Probability values for differences between sampling periods are given in parentheses. *P*-values are based on Chi-square tests with a 0.05 level of significance.

The proportion of sites with submersed vegetation at our transect locations in La Grange Pool and in Pool 26 was relatively high compared to other pools. The backwaters where transects are located are small and protected by levees from the main channel of the Illinois River and most are managed for fishing or waterfowl hunting. Thus, SAV tends to cover the water surfaces, at least during years when flooding does not occur.

Water Depths and Substrates

Mean water depths at transect sites where submersed aquatic plants grew were from 0.3 m in Pool 26 during summer sampling to 1.3 m in La Grange Pool during spring sampling (Table 5). La Grange Pool, where transects are located in backwaters that are protected from high turbidity levels of the Illinois River main channel, was the only pool where water depths reached more than 1 m.

Table 5. Mean depths of submersed aquatic vegetation along sampling transects in Pools 4, 8, 13, and 26 of the Upper Mississippi River and La Grange Pool of the Illinois River during the 1992 spring and summer transect sampling periods.

Location	Mean depth spring sampling	Standard deviation	*N*	Mean depth summer sampling	Standard deviation	*N*
Pool 4	0.7	0.4	733	0.7	0.3	776
Pool 8	0.7	0.3	322	0.5	0.3	778
Pool 13	0.6	0.2	547	0.7	0.3	1,138
Pool 26	0.5	0.1	985	0.3	0.2	495
La Grange Pool	1.3	0.5	194	1.2	0.5	138

Generally, SAV was present mostly on silt and silt-sand substrates throughout all pools. Pools 4 and 13 also reported sand substrates along transects with SAV, reflecting a broader range of habitat types monitored within those pools compared to the others (Table 6).

Table 6. Relative presence (%) of substrate types along transects containing submersed aquatic vegetation during the 1992 spring and summer sampling periods.

	Pool				
Substrate type	**4**	**8**	**13**	**26**	**La Grange**
Silt/clay	75.0	92.2	71.8	100	71.9
Mostly silt with sand	20.8	7.8	19.3	–[a]	28.1
Mostly sand with silt	4.2	–	8.9	–	–

[a] The symbol "–" indicates substrate type was not found.

Pool 4

We found 10 species of SAV along Pool 4 transects during the first sampling period and 14 during the second sampling period (Table 7). No additional species were found during informal surveys that were not found along transects. More species were found along transects in lower Pool 4 (below Lake Pepin) than along transects in the upper pool (above Lake Pepin; Appendix B). Coon's tail, sago pondweed, and curly pondweed had the highest frenquencies during the spring sampling period and contributed to more than 70% of the relative frequencies. These three species contributed to more than 70% of the relative frequencies. Curly pondweed declined from nearly 20% frequency to less than 3% between sampling periods; this decline was not unexpected as the species is a "cool season strategist" and typically completes its annual cycle early in the growing season (Nichols and Shaw 1986). Sago pondweed and coon's tail also declined, but to a lesser degree (Table 7).

Most species, with the exception of sago pondweed, coon's tail, and curly pondweed, were present at frequencies less than 10% during the spring sampling, but showed increases by the summer sampling period.

Wild celery increased from less than 3% to greater than 20%, thus becoming the dominant species by the summer sampling period. Wild celery, coon's tail, and sago pondweed contributed to greater than 50% of the relative frequencies during the summer sampling period. Species with frequencies remaining less than 2% during the season included longleaf pondweed and species of small stature such as chara, nitella, and nodding waternymph (Table 7).

Table 7. Frequencies and relative (%) frequencies of species in Pool 4 during the 1992 spring and summer sampling periods.

	Frequencies [a]		Relative frequencies [a]	
Species	**Spring**	**Summer**	**Spring**	**Summer**
Coon's tail	19.5	15.6	20.8	19.0
Curly pondweed	19.4	2.5	24.8	2.0
Canadian waterweed	5.4	8.8	4.8	8.7
Eurasian watermilfoil	4.4	6.3	4.2	5.5
Flatstem pondweed	2.4	3.6	1.9	2.6
Longleaf pondweed	1.0	0.9	1.0	0.7
Nodding waternymph	–[b]	0.8	–	1.1
Sago pondweed	28.3	16.1	38.7	16.3
Small and leafy pondweeds	1.2	4.3	0.8	4.1
Water stargrass	1.7	9.5	1.2	9.1
Wild celery	2.2	22.3	1.7	30.2
Other species[c]	–	0.7	–	0.7

[a] Frequencies and relative frequencies are based collectively on all transect locations where sampling was performed twice during the growing season. Rounding may cause relative frequency columns to not total 100%.
[b] The symbol "–" indicates species was not found.
[c] Other species include horned pondweed, chara, and nitella.

Although most species remained at similar frequencies at most locations, sago and curly pondweeds decreased at many locations during the season, whereas wild celery and water stargrass increased at several locations. Several species including Canadian waterweed, Eurasian watermilfoil, flatstem pondweed, small and leafy pondweeds, water stargrass, and wild celery significantly increased in Robinson Lake. Water stargrass and wild celery also increased significantly in Big Lake and Peterson Lake (Table 8).

Most species were distributed throughout transect locations in lower Pool 4. Chara and nitella, however, were found only in the Big Lake area. Horned pondweed was found only in Robinson Lake. Species found in upper Pool 4 include curly pondweed, Eurasian watermilfoil, flatstem pondweed, longleaf pondweed, and sago pondweed (Table 8). Community diversity was highest in lower pool locations (Appendix C).

Table 8. Locations in Pool 4 where species were present during the 1992 spring and summer sampling periods.

Species	Decreased in frequency between spring and summer sampling periods[a]	No change between spring and summer sampling periods[b]	Increased in frequency between spring and summer sampling periods[a]
Canadian waterweed		Peterson Lake (lower) Big Lake Big Lake Bay Rice Lake Peterson Lake (upper, middle)	Robinson Lake
Chara		Big Lake Big Lake Bay	
Coon's tail	Big Lake Peterson Lake	Lower Peterson Lake Rice Lake Big Lake Bay Robinson Lake	
Curly pondweed	Lower Peterson Lake Big Lake Robinson Lake Peterson Lake	Big Lake Bay Bay City Flats Goose Lake Dead Slough Lake	
Eurasian watermilfoil		Big Lake Big Lake Bay Lower Peterson Lake Bay City Flats Rice Lake Peterson Lake	Robinson Lake
Flatstem pondweed		Peterson Lake Big Lake Big Lake Bay Mud Lake	Robinson Lake
Horned pondweed		Robinson Lake	
Longleaf pondweed		Peterson Lake Big Lake Robinson Lake Bay City Flats Dead Slough Lake	
Nitella		Big Lake	
Nodding waternymph		Big Lake Bay Robinson Lake Rice Lake Big Lake	
Sago pondweed	Big Lake Robinson Lake Bay City Flats Dead Slough Lake	Peterson Lake Rice Lake Goose Lake Mud Lake Lower Peterson Lake Big Lake Bay	

Table 8. Continued.

Species	Decreased in frequency between spring and summer sampling periods[a]	No change between spring and summer sampling periods[b]	Increased in frequency between spring and summer sampling periods[a]
Small and leafy pondweeds		Big Lake Lower Peterson Lake Big Lake Bay Rice Lake Peterson Lake	Robinson Lake
Water stargrass		Peterson Lake Big Lake Bay Robinson Lake	Robinson Lake Big Lake Lower Peterson Lake
Wild celery		Big Lake Bay Rice Lake	Robinson Lake Lower Peterson Lake Big Lake Peterson Lake

[a] Species that increased or decreased in frequency at a location are significant at the 0.05 probability level (based on z-tests).
[b] Species that did not change significantly may have been untestable due to small sample size during one or both sampling periods.

Pool 8

We found five species of SAV along Pool 8 transects during the spring sampling period and 11 at the same transect locations during the summer sampling period. Curly pondweed and sago pondweed were the only two species with frequencies greater than 10% during the spring sampling period, accounting for nearly 80% of the relative frequencies during that sampling period. By the summer sampling period, curly pondweed dropped in frequency and relative frequency, yet remained third highest in relative frequency. Sago pondweed and Eurasian watermilfoil increased in frequency between spring and summer sampling. Common bladderwort, flatstem pondweed, longleaf pondweed, nodding waternymph, southern waternymph, water stargrass, and wild celery were not found until the summer sampling period. All these species, however, remained at frequencies less than 2%, thus contributing to less than 5% of the total relative frequencies for the summer sampling period (Table 9).

Significant increases in species frequencies occurred at several locations between spring and summer sampling. Coon's tail and sago pondweed, which had decreased during the 1991 season, increased during the 1992 season, especially in Lawrence Lake. Eurasian watermilfoil increased at two locations, Horseshoe Island and Lawrence Lake, and curly pondweed increased at Lawrence Lake. No species significantly decreased at any location and several species did not change during the season (Table 10).

Most species were distributed in at least two transect locations, except for common bladderwort, southern waternymph, and wild celery, which were found only at Lawrence Lake. Horned pondweed was found only at Horseshoe Island (Table 10). Community diversity increased at several locations between spring and summer sampling, especially in Lawrence Lake, Goose Island, and Target Lake (Appendix C).

Table 9. Frequencies and relative (%) frequencies of species in Pool 8 during the 1992 spring and summer sampling periods.

Species	Frequencies[a]		Relative frequencies[a]	
	Spring	Summer	Spring	Summer
Coon's tail	2.0	8.8	3.4	10.8
Common bladderwort	–[b]	0.1	–	0.1
Curly pondweed	20.8	16.6	51.3	23.8
Eurasian watermilfoil	9.4	19.8	16.5	24.0
Flatstem pondweed	–	0.4	–	0.5
Horned pondweed	0.4	–	0.6	–
Longleaf pondweed	–	0.4	–	0.4
Nodding waternymph	–	1.6	–	2.2
Sago pondweed	16.3	28.3	28.1	37.4
Southern waternymph	–	0.1	–	0.1
Water stargrass	–	0.5	–	0.5
Wild celery	–	0.1	–	0.2

[a] Frequencies and relative frequencies are based collectively on all transect locations sampled during both sampling periods pooled together.
[b] The symbol "–" indicates the species was not found.

Table 10. Locations in Pool 8 where species were present during the 1992 spring and summer sampling periods.

Species	Decreased in frequency between spring and summer sampling periods[a]	No change between spring and summer sampling periods[b]	Increased in frequency between spring and summer sampling periods[a]
Common bladderwort		Lawrence Lake	
Coon's tail		Shady Maple Target Lake Goose Island	Lawrence Lake
Curly pondweed		Horseshoe Island Shady Maple Goose Island	Lawrence Lake
Eurasian watermilfoil		Shady Maple Target Lake Goose Island	Horseshoe Island Lawrence Lake
Flatstem pondweed		Lawrence Lake Goose Island	
Horned pondweed		Horseshoe Island	

Table 10. Continued.

Species	Decreased in frequency between spring and summer sampling periods[a]	No change between spring and summer sampling periods[b]	Increased in frequency between spring and summer sampling periods[a]
Longleaf pondweed		Shady Maple Goose Island Target Lake	
Nodding waternymph		Horseshoe Island Goose Island Target Lake Lawrence Lake	
Sago pondweed		Shady Maple Goose Island Target Lake	Horseshoe Island Lawrence Lake
Southern waternymph		Lawrence Lake	
Water stargrass		Horseshoe Island Lawrence Lake Shady Maple	
Wild celery		Lawrence Lake	

[a] Species that increased or decreased in frequency at a location are significant at the 0.05 probability level (based on z-tests).
[b] Species that did not change significantly may have been untestable due to small sample size during one or both sampling periods.

Pool 13

We found seven species along Pool 13 transects during the 1992 spring sampling period and 12 during the summer sampling period (Appendix B). No species were found during the informal surveys that were not found at transect locations. Flatstem pondweed and water stargrass were probably both present, which would add one species to the count for each sampling period, but we did not distinguish between the two species while in the field. During spring sampling, sago pondweed was the only species with a frequency more than 10%. Most species, however, showed increases in frequencies between sampling periods, especially coon's tail (increasing from 6% to more than 20%), Eurasian watermilfoil (increasing from less than 1% to more than 10%), and flatstem pondweed (or water stargrass; increasing from less than 1% to more than 10%). Species not present during spring sampling but present during summer sampling included Canadian waterweed, chara, nodding waternymph, small and leafy pondweeds, and southern waternymph. These species, however, remained at individual frequencies less than 3% and contributed to less than 5% of the total relative frequencies for the summer sampling period. Sago pondweed remained the species with the highest relative frequency during both sampling periods, dominating relative frequencies at 81.9% during spring sampling and still dominating relative frequencies during summer sampling at nearly 50% (Table 11).

Most species had significant increases in frequencies at some locations during the 1992 growing season. The only decreases observed were sago pondweed which decreased at Johnson Creek Levee, and curly pondweed, which decreased in Brown's Lake (Table 12). Most species were found at several transect locations, except for small and leafy pondweeds, which were found only at Pomme de Terre, and nodding waternymph and chara, which were found only at the Johnson Creek locations. Community diversity increased at most transect locations between sampling periods (Appendix C).

Table 11. Frequencies and relative frequencies (%) of species in Pool 13 during the 1992 spring and summer sampling periods.

Species	Frequencies[a]		Relative frequencies[a]	
	Spring	Summer	Spring	Summer
Canadian waterweed	–[b]	1.8	–	1.3
Chara	–	0.3	–	0.2
Coon's tail	6.0	24.3	5.6	17.9
Curly pondweed	8.4	8.9	8.4	5.4
Eurasian watermilfoil	0.5	11.6	0.5	7.3
Longleaf pondweed	2.0	5.7	2.3	3.7
Nodding waternymph	–	3.3	–	2.1
Sago pondweed	49.2	53.6	81.9	48.0
Small and leafy pondweeds	–	0.2	–	0.1
Southern waternymph	–	1.5	–	0.8
Wild celery	1.1	6.6	1.1	4.6
Other species[c]	0.1	10.4	0.1	8.7

[a] Frequencies and relative frequencies are based collectively on all transect locations pooled together.
[b] The symbol "–" indicates the species was not found.
[c] Other species include water stargrass and flatstem pondweed.

Table 12. Locations in Pool 13 where species were present during the 1992 spring and summer sampling periods.

Species	Decreased in frequency between spring and summer sampling periods[a]	No change between spring and summer sampling periods[b]	Increased in frequency between spring and summer sampling periods[a]
Canadian waterweed		Spring Lake Pomme de Terre	Johnson Creek Johnson Creek Levee
Chara		Johnson Creek	
Coon's tail		Brown's Lake	Johnson Creek Johnson Creek Levee Pomme de Terre Spring Lake Savanna Bay
Curly pondweed	Brown's Lake	Potter's Marsh Johnson Creek Johnson Creek Levee Spring Lake Savanna Bay Pomme de Terre Brown's Lake	

Table 12. Continued.

Species	Decreased in frequency between spring and summer sampling periods[a]	No change between spring and summer sampling periods[b]	Increased in frequency between spring and summer sampling periods[a]
Eurasian watermilfoil		Savanna Bay Potter's Marsh Spring Lake	Johnson Creek Johnson Creek Levee Pomme de Terre
Flatstem pondweed/water stargrass		Pomme de Terre Brown's Lake Savanna Bay Spring Lake Potter's Marsh	Johnson Creek Johnson Creek Levee
Longleaf pondweed		Brown's Lake Savanna Bay	Johnson Creek Johnson Creek Levee Pomme de Terre
Nodding waternymph		Pomme de Terre Johnson Creek Johnson Creek Levee Spring Lake Savanna Bay	Johnson Creek
Sago pondweed	Johnson Creek Johnson Creek Levee	Brown's Lake Savanna Bay Potter's Marsh Pomme de Terre	Brown's Lake Spring Lake
Small and leafy pondweeds		Pomme de Terre	
Southern waternymph			Johnson Creek Johnson Creek Levee
Wild celery		Pomme de Terre Potter's Marsh Spring Lake	Johnson Creek Johnson Creek Levee Pomme de Terre

[a] Species that increased or decreased in frequency at a location are significant at the 0.05 probability level (based on z-tests).
[b] Species that did not change significantly may have been untestable due to small sample size during one or both sampling periods.

Pool 26

We found six species of SAV along Pool 26 transects during the spring and summer sampling periods. Two additional species, horned pondweed and water stargrass, were found at low frequencies in Fuller and Stump Lakes during the spring sampling (Fuller and Stump Lakes were only sampled during spring and are not included in Table 13). Frequencies and relative frequencies were dominated by coon's tail, sago pondweed, and curly pondweed during spring sampling and by coon's tail and sago pondweed during summer sampling with sago pondweed owning the highest relative frequency during both periods. Small and leafy pondweeds and curly pondweed reached highest frequencies during the spring. Canadian waterweed, longleaf pondweed, and southern waternymph were found rarely (less than 2%; Table 13).

Table 13. Frequencies and relative frequencies (%) of species in Pool 26 during the 1992 spring and summer sampling periods.

Species	Frequencies[a]		Relative frequencies[a]	
	Spring	Summer	Spring	Summer
Canadian waterweed	0.7	0.7	0.3	0.3
Coon's tail	31.7	33.2	34.9	34.8
Curly pondweed	17.8	4.5	16.1	1.8
Longleaf pondweed	0.2	–[b]	0.2	–
Sago pondweed	46.2	54.2	41.4	58.7
Small and leafy pondweeds	10.3	7.1	7.0	3.2
Southern waternymph	–	1.4	–	1.2

[a] Frequencies and relative frequencies are based on two locations pooled together; Calhoun Point and Swan Lake.
[b] The symbol "–" indicates the species was not found.

Curly pondweed and small and leafy pondweeds decreased significantly during the growing season at Calhoun Point. An increase in both sago pondweed occurred in Swan Lake (Table 14). Community diversity was highest in Fuller and Stump Lakes during spring sampling (Appendix C).

Table 14. Locations in Pool 26 where species were present during the 1992 spring and summer sampling periods.

Species	Decreased in frequency between spring and summer sampling periods[a]	No change between spring and summer sampling periods[b]	Increased in frequency between spring and summer sampling periods[a]
Canadian waterweed		Calhoun Point	
Coon's tail		Calhoun Point Swan Lake	
Curly pondweed	Calhoun Point	Swan Lake	
Longleaf pondweed		Stump Lake Calhoun Point	
Sago pondweed		Calhoun Point	Swan Lake
Small and leafy pondweeds	Calhoun Point		
Southern waternymph		Swan Lake	

[a] Species that increased or decreased in frequency at a location are significant at the 0.05 probability level (based on z-tests).
[b] Species that did not change significantly may have been untestable due to small sample size during one or both sampling periods.

La Grange Pool

We found eight species of submersed aquatic macrophytes along La Grange Pool transects during the 1992 spring sampling period, and seven during the summer period. Species frequencies in La Grange Pool were dominated by Eurasian watermilfoil, coon's tail, and curly pondweed in spring, reaching a combined relative frequency of more than 90%. By summer sampling, curly pondweed had dropped to less than 7% frequency, and Eurasian watermilfoil (61.6%) and sago pondweed (21.1%) dominated the relative frequencies. Eurasian watermilfoil has been a problem species in Spring Lake, covering most the water surface in the lower portion where transects are located. Frequencies of Eurasian watermilfoil typically occupied at least 80% of all sites sampled. Coon's tail dominated at Point Lake, a location where Eurasian watermilfoil has not been found. Relative frequencies reflect the high frequencies of Eurasian watermilfoil and coon's tail. La Grange Pool backwaters are the only locations within our study areas where we found western waterweed, although positive identification by an expert is still needed (Table 15). Community diversity increased at Bulrush Pond, but decreased at Spring Lake and Point Lake between sampling periods (Appendix C).

Table 15. Frequencies and relative frequencies (%) of species in La Grange Pool, Illinois River, during the 1992 spring and summer sampling periods.

	Frequencies[a]		Relative frequencies[a]	
Species	**Spring**	**Summer**	**Spring**	**Summer**
Chara	5.1	8.3	3.8	7.3
Coon's tail	17.6	21.2	12.2	21.1
Curly pondweed	35.3	6.1	22.3	3.4
Eurasian watermilfoil	69.8	56.8	56.2	61.6
Longleaf pondweed	2.9	3.8	1.3	2.4
Sago pondweed	7.3	3.0	3.3	1.4
Small and leafy pondweeds	<0.1	–[b]	0.2	–
Western waterweed	2.2	4.5	0.7	2.8

[a] Frequencies and relative frequencies are based on all transect locations pooled together.
[b] The symbol "–" indicates the species was not found.

Only two species had significant change in frequency between sampling periods; Eurasian watermilfoil declined in Spring Lake and Bulrush Pond and curly pondweed declined in Spring Lake. Coon's tail and sago pondweed were found at all locations, whereas curly pondweed, western waterweed, and chara were found only in Spring Lake (Table 16).

Table 16. Locations in La Grange Pool, Illinois River, where species were present during the 1992 spring and summer sampling periods.

Species	Decreased in frequency between spring and summer sampling periods[a]	No change between spring and summer sampling periods[b]	Increased in frequency between spring and summer sampling periods[a]
Chara		Spring Lake	
Coon's tail		Point Lake Spring Lake Bulrush Pond	
Curly pondweed	Spring Lake		
Eurasian watermilfoil	Spring Lake Bulrush Pond		
Longleaf pondweed		Bulrush Pond	
Sago pondweed		Point Lake Bulrush Pond Spring Lake Grape Island	
Western waterweed		Spring Lake	

[a] Species that increased or decreased in frequency at a location are significant at the 0.05 probability level (based on z-tests).
[b] Species that did not change significantly may have been untestable due to small sample size during one or both sampling periods.

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Appendix A

Locations, Number of Transects and Sites, Sampling Dates, and Distances Between Sites Sampled in Pools 4, 8, 13, and 26 of the Upper Mississippi River and La Grange Pool of the Illinois River During the 1992 Sampling Season

Location	Number transects	Number of sites in spring	Number of sites in summer	Dates sampled in spring	Dates sampled in summer	Distance between sites (m)
Pool 4						
Dead Slough Lake (M789.2, M788.5, M788.0)[a]	9	130	129	6/9–11	7/30–31; 8/3	30
Goose Lake (M788.G)[b]	3	26	23	6/4	7/27	30
Mud Lake (M791.3)	3	55	56	6/4	7/29	30
Bay City Flats (Catherine Pass[c]; M787.0)	3	76	76	6/11–12	8/13	30
Robinson Lake (M758.R)[b]	9	198	168	5/21, 26–28	7/20–21, 23	30
Big Lake Bay (M758.5)	3	32	27	5/28	7/24	30
Rice Lake (M758.0)	3	26	28	6/1	7/27	30
Big Lake (M757.5)	5	133	123	6/1–3	7/27–28	30
Peterson Lake (M754.8, M754.5)	6	71	51	5/14–15, 19	7/15	30
Lower Peterson Lake (M753.5)	4	109	156	5/20–21	7/16–17	30
Total Pool 4	**48**	**856**	**837**	**22**	**19**	
Pool 8						
Target Lake (M696.0)	7 (spring) 11 (summer)	105	259	5/12, 14; 6/17	8/05–6, 10	15
Goose Island (M692.0)	5	111	113	5/13; 6/3	7/27, 29	15
Lawrence Lake (M691.0)	6 (spring) 10 (summer)	261	398	5/18–19, 21; 6/9, 11–12	7/28, 31; 8/12–14, 17–19	15
Shady Maple (M690.0)	3	106	105	6/2, 8	8/20, 26	15

Location	Number transects	Number of sites in spring	Number of sites in summer	Dates sampled in spring	Dates sampled in summer	Distance between sites (m)
Horseshoe HREP[d] (M687.0)	5	75	83	6/5, 19	8/11, 19	15
Stoddard (M684.0)	4 (summer)	not sampled	47	not sampled	8/25, 27	15
Total Pool 8	**26 (spring) 38 (summer)**	**658**	**1,005**	**17**	**21**	
Pool 13						
Brown's Lake (M545.1, M544.5)	25	280	354	6/05, 8–11	7/16–17, 20–21, 23, 27	15 and 30
Savanna Bay (M541.5, M540.5, M539.5)	12	146	148	5/26–27, 29	7/28, 31; 8/3	15
Spring Lake (M534.8, M533.6, M532.0)	12	126	136	5/29; 6/3, 5	7/29; 8/4, 5	15
Pomme de Terre (M526.0)	5	69	81	5/22	8/6	15
Potter's Marsh (M524.0)	6	71	41	5/19	8/11, 13	15
Johnson Creek Levee (M523.5)	4	81	73	6/12	8/13–14	15
Lower Johnson Creek (M523.0)	2	40	56	5/20	8/12	15
Total Pool 13	**66**	**813**	**889**	**18**	**20**	
Pool 26						
Calhoun Point (I003.0)[e,f]	21	157	157	5/28; 6/1, 3	7/20, 23	15
Swan Lake (I005.5)	11 (spring) 3 (summer)	291	282	5/20–21, 26–27	7/15–16	15
Stump Lake (I010.0, I011.5)	8 (spring)	200	not sampled	6/8–9	not sampled	15
Total Pool 26	**40 (spring) 32 (summer)**	**648**	**439**	**10**	**4**	

Location	Number transects	Number of sites in spring	Number of sites in summer	Dates sampled in spring	Dates sampled in summer	Distance between sites (m)
La Grange Pool						
Point Lake (I100.0)[e]	6	20	21	5/20	8/4	15
Spring Lake (I135.5)	5	87	85	5/18, 28–29; 6/4, 9–10	7/22–23, 28; 8/3, 10	15
Bulrush Pond (I140.7)	2	16	16	6/11	8/11	15
Grape Island (I086.4)	3	13	9	5/22; 6/3	7/24	15
Total La Grange Pool	**11**	**136**	**132**	**8**	**7**	

[a] Mississippi River miles, measured from the confluence of the Mississippi and Ohio Rivers.
[b] "G" and "R" to distinguish this lake from another lake with the same river mile.
[c] Locally recognized name.
[d] Habitat Rehabilitation and Enhancement Project.
[e] Illinois River miles, measured from the confluence of the Illinois and Mississippi Rivers.
[f] Pool 26 is located at the confluence of the Illinois and Mississippi Rivers and the portions named here extent up the Illinois River, are managed by the Illinois Department of Natural Resources, and are designated by Illinois River miles.

Appendix B

Species of Submersed and Floating-leaved Aquatic Macrophytes Occurring at Transect Sites in Pools 4, 8, 13, and 26 of the Upper Mississippi River and La Grange Pool of the Illinois River

Species	Pool 4[a]	Pool 8	Pool 13	Pool 26	La Grange Pool
Submersed Aquatic Species					
Canadian waterweed (*Elodea canadensis* L.)	x	–	x	x	–
Chara (*Chara* spp.)	x	–	x	–	x
Common bladderwort (*Utricularia macrorhiza* L.)	–	x	–	–	–
Coon's tail (*Ceratophyllum demersum* L.)	x	x	x	x	x
Curly pondweed (*Potamogeton crispus* L.)	x	x	x	x	x
Eurasian watermilfoil (*Myriophyllum spicatum* L.)	lower pool only x[b]	x	x	–[c]	x
Flatstem pondweed (*Potamogeton zosteriformis* Fern)	lower pool only x	x	x[d]	–	–
Horned pondweed (*Zannichellia palustris* L.)	lower pool only x	x	–	x	–
Longleaf pondweed (*Potamogeton nodosus* Poiret.)	x	x	x	x	x
Nitella (*Nitella* spp.)	x	–	–	–	–
Nodding waternymph (*Najas flexilis* [Willd.] Rostke. & Schmidt)	lower pool only x	x	x	–	–
Sago pondweed (*Potamogeton pectinatus* L.)	x	x	x	x	x
Small and leafy pondweeds (*Potamogeton pusillus* and *P. foliosus* L.)	lower pool only x	–	x	x	x
Southern waternymph (*Najas guadalupensis* [Spreng.] Magnus)	–	x	x	x	–
Water stargrass (*Heteranthera dubia* L.)	lower pool only x	x	x	x	–
Western waterweed (*Elodea nuttallii* [Planch.] St. John)	–	–	–	–	x

Species	Pool 4[a]	Pool 8	Pool 13	Pool 26	La Grange Pool
Wild celery, American eelgrass (*Vallisneria americana* Michx.)	lower pool only x	x	x	–	–
Floating-leaved Species					
American lotus (*Nelumbo lutea* [Willd.] Pers.)	x	x	x	–	x
White waterlily (*Nymphaea odorata* Ait.)	x	x	–	–	–
Yellow pondlily (*Nuphar lutea* [L.] Sm.)	–	x	–	–	–
Total per pool[e]	**16**	**15**	**14**	**9**	**9**

[a] In Pool 4, species were found in both upper and lower pools unless otherwise indicated.
[b] The symbol "x" indicates the species was present during at least one sampling period.
[c] The symbol "–" indicates the species was not found.
[d] Flatstem pondweed and water stargrass are listed as both present in Pool 13 but no distinction was made between the two species when sampled in the field.
[e] Total per pool is the total number of species present regardless of sampling period.

Appendix C

Location and Community Diversity for Spring and Summer Sampling Periods

Location	Spring sample diversity[a]	Summer sample diversity[a]
Pool 4		
Lower Peterson Lake	0.74	0.62
Peterson Lake	0.75	0.72
Big Lake	0.81	0.47
Rice Lake	0.60	0.63
Big Lake Bay	0.64	0.77
Robinson Lake	0.71	0.82
Bay City Flats	0.00	0.03
Dead Slough Lake	0.06	0.05
Goose Lake	0.35	0.14
Mud Lake	0.08	0.00
Pool 8		
Stoddard backwater	–[b]	0.33
Pool 8 islands	0.36	0.37
Shady Maple	0.43	0.50
Lawrence Lake	0.34	0.66
Goose Island	0.45	0.70
Target Lake	0.05	0.16
Pool 13		
Johnson Creek	0.65	0.74
Johnson Creek Levee	0.39	0.78
Potter's Marsh	0.00	0.39
Pomme de Terre	0.54	0.74
Spring Lake	0.63	0.76
Savanna Bay	0.50	0.65
Brown's Lake	0.10	0.11

Location	Spring sample diversity[a]	Summer sample diversity[a]
Pool 26		
Calhoun Point	0.56	0.26
Swan Lake	0.00	0.04
Stump Lake	0.71	-
Fuller Lake	0.78	-
La Grange Pool		
Grape Island	0.00	0.00
Point Lake	0.18	0.10
Spring Lake	0.50	0.29
Bulrush Pond	0.30	0.68

[a] Community diversity is calculated from a modification of Simpson's index (1949) calculated as $1 - \sum(rf^2)$ where rf is the relative frequency of each species.

[b] The symbol "–" indicates no samples were taken during the sampling period at that location.

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13. ABSTRACT (Maximum 200 words)

Aquatic vegetation of the Upper Mississippi River System is monitored as part of the Long Term Resource Monitoring Program. This report summarizes the 1992 effort of monitoring submersed aquatic vegetation (SAV) along transects permanently established in vegetated locations within four navigation pools of the Upper Mississippi River and one navigation pool of the Illinois River. More species of submersed aquatic macrophytes were found along transects in lower Pool 4 than in any other reach. La Grange Pool and Pool 26 transects had the fewest species. Across all pools, sago pondweed (*Potamogeton pectinatus*) and coon's tail (*Ceratophyllum demersum*) were the species most frequently found. Several species of SAV were seasonally dynamic at the transect locations, with changes in frequencies especially common among sago and curly (*P. crispus*), and species of narrow-leaved pondweeds. Many of the species present in Pools 8 and 13 increased in frequencies between sampling periods, resulting in a significantly higher proportion of sites with SAV by the summer sampling period. Although frequencies of individual species changed during the growing season in Pools 4 and 26 and La Grange Pool, the proportion of sites with SAV remained stable. Community diversity within each pool was similar between sampling periods except in Pool 13 where diversity increased at most locations during the season.

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The Long Term Resource Monitoring Program (LTRMP) for the Upper Mississippi River System was authorized under the Water Resources Development Act of 1986 as an element of the Environmental Management Program. The mission of the LTRMP is to provide river managers with information for maintaining the Upper Mississippi River System as a sustainable large river ecosystem given its multiple-use character. The LTRMP is a cooperative effort by the U.S. Geological Survey, the U.S. Army Corps of Engineers, and the States of Illinois, Iowa, Minnesota, Missouri, and Wisconsin.